Quantitative Precipitation and River Flow Predictions over Southwestern United States

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We present a regional numerical weather and hydrologic prediction system for southwestern United States and its application to quantitative precipitation forecast (QPF) and river flow during the winters of 1994-1995 and 1995-1996. This Coupled Atmosphere River Flow Simulation (CARS) System (Miller and Kim 1996) is composed of the Mesoscale Atmospheric Simulation (MAS) model (Soong and Kim 1996) which is interactively coupled with a physically-based land-surface model (Kim and Ek 1995). The river flow model (TOPMODEL: Beven and Kirkby 1979) is unidirectionally coupled to the MAS model using the terrain information obtained from an Automated Land Analysis System (ALAS: Miller 1996). The prediction domain (1600 km x 1300 km) includes California, Nevada, and parts of the states surrounding them. The model is set up with 20 km x 20 km horizontal resolution with 18 layers in the vertical.

Daily forecasts start from the 80 km resolution NCEP (former NMC) ETA-model initial and forecast data. The preprocessor interpolates the ETA-model data over the regional forecast domain at 20 km x 20 km resolutions, and computes the tendency of the large-scale data at the lateral boundaries at 6-hr intervals. This initial and lateral boundary data are then fed into the fully coupled atmosphere-surface model to generate 48-hr forecasts. The 6-hr mean regional prediction data is used as input to run the river flow model. This numerical prediction procedure has been mostly automated on a DEC-Alpha workstation. At present, we are expanding river flow calculations to four California watersheds: Russian River, Feather River, American River, and the Shasta Inflow. These four watersheds are important for their flood potential and water resources management. This NWP system is designed to be flexible: Any component of this NWP system such as the large scale data, initialization scheme, mesoscale model, and river flow model, can be easily replaced when improved and validated models become available.

Our NWP system showed good skill in simulating precipitation and river flow over the major watersheds within California, especially during the heavy precipitation periods. The skill during dry/lower river level periods is lower (about 50%) compared to heavy precipitation periods (80-90%), and may be due to deficiencies in the cumulus parameterization and uncertainties in the soil characteristics. Also, the quality of the large-scale prediction appears to be crucial for an accurate regional predictions. In addition to daily NWP, we also ran the CARS System using the initial and 6-hr ETA-model prediction data throughout the winter seasons. The purpose of this simulation is to evaluate the NWP system and to obtain fine-resolution wintertime climatology of southwestern United States. This diagnostic simulation shows that our NWP system is capable of simulating accurate spatial and temporal distribution of precipitation. An application of this NWP system for water resources study will also be discussed.

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